What is claimed:

1. A method of making a freestanding reactive multilayer foil composed of a plurality of alternating layers that can react exothermically, comprising the steps of:

providing a substrate;

vapor depositing the alternating layers on the substrate to form the reactive multilayer foil; and

separating the multilayer foil from the substrate.

2. The method of claim 1 wherein the substrate has sufficient adherence to the deposited layers to retain the layers during deposition but insufficient adherence to prevent removal of the multilayer foil after deposition.

3. The method of claim 1 wherein the layers comprise one or more layers of aluminum, and at least one of the layers of aluminum is deposited in contact with the substrate .

4. The method of claim 3 wherein the substrate comprises silicon.

5. The method of claim 1 wherein the substrate comprises a coating of a release material or a coating of an adhesion material.

6. The method of claim 1 wherein the substrate comprises a removable sacrificial layer.

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7. The method of claim 1 wherein the substrate comprises a removable sacrificial layer of copper, brass or photoresist.

8. The method of claim 1 wherein the vapor depositing comprises physical vapor deposition.

9. The method of claim 8 wherein the vapor depositing comprises magnetron sputtering or electron beam evaporation.

10. The method of claim 1 wherein the substrate is cooled during the vapor depositing.

11. The method of claim 1 wherein the layers are deposited to form a multilayer foil having a thickness in the range 50μm-1cm.

12. The method of claim 1 wherein the vapor depositing is under conditions chosen to minimize stress in the deposited layers.

13. A method of bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a freestanding reactive multilayer foil;

pressing the bodies together against the foil; and

igniting the reactive foil.

14. The method of claim 13 wherein at least one of the bodies is a semiconductor or microelectronic device.

15. The method of claim 13 wherein the reactive multilayer foil has a thickness in excess of 10μm.

16. The method of claim 13 wherein the bodies have coefficients of thermal expansion differing by at least 1 μm/m/°C.

17. The method of claim 13 wherein the first body comprises metal and the second body comprises ceramic material.

18. The product made by the method of claim 13.

19. A reactive multilayer foil comprising:

a foil composed of alternating layers that react exothermically , wherein the foil includes a plurality of openings through the foil.

20. A reactive multilayer foil according to claim 19 wherein the openings are filled with meltable material, propellant, or material that changes or reacts on heating.

21. A reactive multilayer foil according to claim 19 wherein the openings are periodically arranged across the area of the foil.

22. A method of making a reactive multilayer foil comprising the steps of:

providing a substrate having a surface including a plurality of preformed openings, bumps, or particles of thickness or depth similar to or greater than the multilayer foil to be deposited;

depositing on the surface a plurality of layers to form the reactive multilayer foil; and

separating the multilayer foil from the substrate.

23. A method of making a reactive multilayer foil comprising the steps of:

providing a flat substrate;

depositing on the substrate a plurality of layers to form a reactive multilayer foil;

depositing a masking layer on top of the reactive foil;

patterning the masking layer with a plurality of holes;

etching the reactive foil through the holes; and

separating the multilayer foil from the substrate.

24. A method of making a reactive multilayer foil comprising the steps of:

providing a flat substrate;

depositing on the substrate a plurality of layers to form a reactive multilayer foil;

and

mechanically pressing a plurality of holes into the reactive foil.

25. A method of making a reactive multilayer foil comprising the steps of:

making a reactive multilayer foil having a plurality of openings through the foil, and

filling the openings in the multilayer foil with meltable material, propellant, or material that will change or react on heating when the reactive foil is ignited.

26. A method of bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a reactive multilayer foil and at least one meltable joining material, the reactive multilayer foil having a plurality of openings through the thickness of the foil,

pressing the bodies together against the foil and the joining material; and

igniting the reactive foil to melt the joining material and permit the melted material to flow through the openings to join the first and second bodies.

27. The method of claim 26 wherein at least one of first body or the second body comprise a semiconductor or a microelectronic device.

28. The method of claim 26 wherein the first body and the second body have CTEs that differ by more than about 1μm/m/°C.

29. The product made by the method of claim 26.

30. The product made by the method of claim 27.

31. The product made by the method of claim 28.

32. A composite reactive multilayer foil comprising:

at least one first set of reactive layers; and

at least one second set of reactive layers in thermal contact with the first set, the layers of the first set having thicknesses which are relatively larger than those of the second set, whereby the layers of the second set, upon ignition, ignite the thicker layers of the first set.

33. A composite reactive multilayer foil comprising:

a first set of reactive layers; and

a second set of reactive layers in thermal contact with the first set, the layers of the first set having compositions which are relatively more reactive than the second set, whereby the layers of the first set, upon ignition, ignite the less reactive layers of the second set.

34. A reactive multilayer foil comprising:

a multilayer foil having an area composed of at least two different regions, one or more first regions composed of layers that can react exothermically to form electrically

conductive material and one or more second regions which are non-conductive or react to form non-conductive material.

35. A method of connecting a semiconductor or microelectronic device having one or more electrical contacts to a substrate having one or more receiving contacts, comprising the steps of:

disposing between the device and the substrate a reactive multilayer foil composed of one or more first regions that can react exothermically to form electrically conductive regions and one or more second regions which are non-conductive or react to form non-conductive material.;

registering the contacts of the device, the contacts of the substrate and the first regions of the foil,

pressing the device and the substrate together against the foil; and

igniting the foil.

36. A method for bonding a first body to a second body comprising the steps of:

disposing between the first body and the second body, a reactive multilayer foil comprising a plurality of successive exothermic reactive layers that react to form a joining material;

pressing the bodies together against the foil; and

igniting the foil.

37. The method of claim 36 wherein at least one of the first and second bodies comprise metallic glass.

38. The method of claim 37 wherein the reactive multilayer foil comprises alternate layers of alloys that, after reaction and cooling, are amorphous.

39. The method of claim 37 wherein the reactive multilayer foil comprises alternate layers of an alloy comprising Ni or Cu, an alloy comprising Ti, Zr, or Hf, and an alloy containing primarily Al.

40. A method of bonding a first body to a second comprising the steps of:

disposing between the first body and the second body, a freestanding reactive multilayer foil and at least one layer of meltable joining material;

pressing the bodies together against the foil and joining material; and

igniting the reactive foil to melt the joining material.

41. The method of claim 40 wherein the joining material is coated on the foil.

42. The method of claim 40 wherein the joining material is freestanding.

43. A bonded structure comprising:

a first body;

a second body bonded to the first body by a joining region, the joining region comprising a reacted multilayer structure including a periodic array of openings therethrough, the structure embedded in a matrix of meltable joining material extending through the openings to join the first body and the second body.